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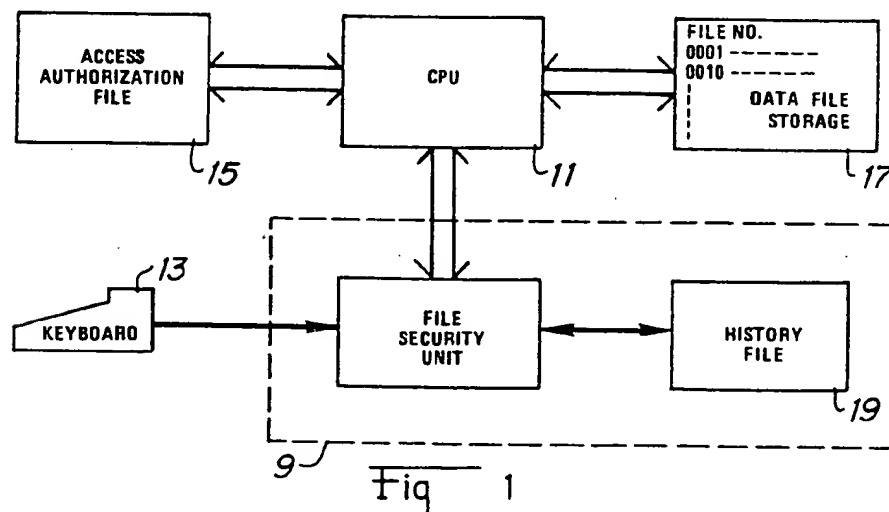
None

(58) Field of search

G4A

(54) File Access Security Method and Means

(57) An improved file access security technique and associated apparatus 9 accesses data which is stored at 17 in encrypted form under one encryption key and re-stores the data re-encrypted under another encryption key, and produces at 19 a record of each access and data re-encryption both as the control source of encryption keys for access and re-entry of encrypted data and as a secured audit record of users that had access to each file.



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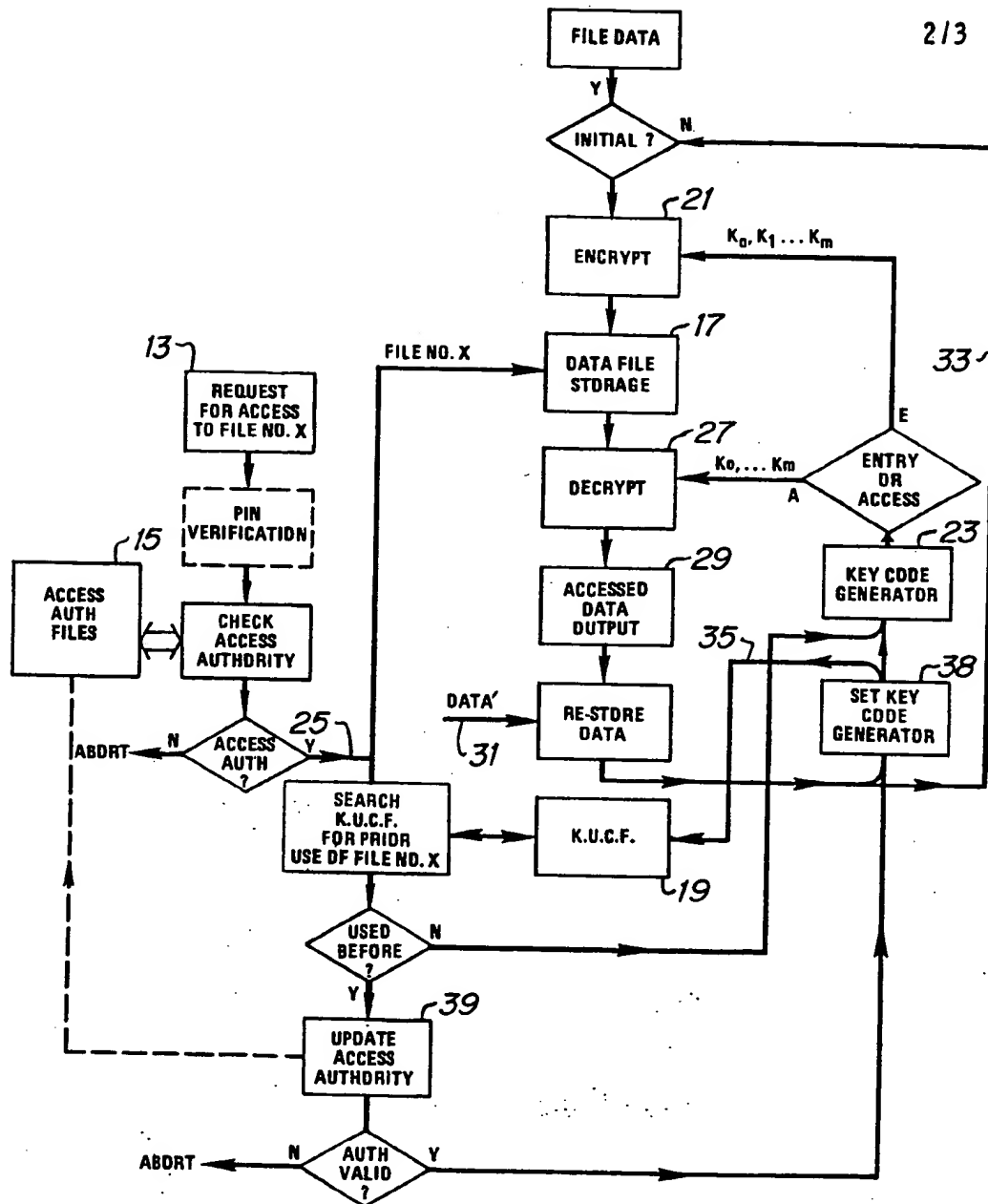


Fig. 2

## SPECIFICATION

## File Access Security Method and Apparatus

This invention is concerned with a method of and apparatus for securing data files in storage.

5 Many known computer-controlled operations on secured data files require verification of the identity of an individual seeking to access a file before the data (usually in encrypted form) can be accessed (see, for example, U.S. Patents  
10 3,938,091, 3,587,051, 3,611,293 and 4,198,619). In addition, many known record-securing schemes including those associated with credit cards, require verification of both the authority of the using individual and the  
15 authenticity of the data in the record, to protect against unauthorized users and against counterfeit or duplicate records. Schemes of this type are disclosed in U.S. Patents 4,304,990, 4,328,414 and 4,357,429.

20 One disadvantage associated with computer-controlled security schemes of these types is that there is typically no indication left on file of who gained access to a secured record.

The present invention provides a method of  
25 securing data files in storage against unauthorized access, the method comprising the steps of encrypting file data as a selected logical combination thereof with an initial one of a plurality of encryption key codes to produce file  
30 data in encrypted form for storage at selected file address locations, establishing a record of accesses to each selected file address location and the one of the plurality of encryption key codes with which the file data at the address  
35 location is encrypted, processing a request for access to file data at a selected file address location by determining from the record the number of prior accesses thereof and the encryption key code associated therewith,  
40 decrypting file data at the selected file address location using said associated encryption key code, re-encrypting file data for said selected file address location using a new one of said plurality of encryption key codes in said selected logical  
45 combination, storing the newly re-encrypted file data at the accessed file address location, and modifying the record to indicate an additional access to the selected file address location and the new encryption key code associated  
50 therewith.

In performing a method as set forth in the last preceding paragraph, it is preferred that in carrying out the step of decrypting, file data at a selected file address location is decrypted using  
55 said initial encryption key code in response to determination from the record that said selected file address location was not previously accessed.

A method as set forth in either one of the last two immediately preceding paragraphs may  
60 further comprise the additional steps of establishing a file of user access authorizations, and prior to accessing a selected file address location, determining the authorization status of a

user to gain access to the selected file address location.

65 A method as set forth in the last preceding paragraph may further comprise the additional step of selectively altering the access authorization of a user to gain subsequent access to the selected file address location in response to re-encryption of the file data for storage at the selected file address location.

A method as set forth in any one of the last four immediately preceding paragraphs may  
75 further comprise the steps of reinitializing all the file data by decrypting the file data at each selected file address location using the encryption key code thereof determined from the record, and re-encrypting the file data at each such file  
80 address location using a new initial one of a plurality of key codes.

In performing a method as set forth in the last preceding paragraph, it is preferred that in carrying out the reinitialization step, the file data  
85 at any file address location which is not indicated in the record to have been accessed previously is decrypted using the initial encryption key code.

The present invention also provides apparatus for securing data filed in storage against  
90 unauthorized access, comprising storage means for storing file data in encrypted form at selectable file address locations, encryption means for supplying encrypted file data to a selected file address location as the logical  
95 encoding combination of file data and an encryption key signal applied thereto, generator means for applying selected encryption key signals to the encryption means, record means for producing indication of selected file address  
100 locations and key code signals associated with encryption of file data stored therein, circuit means responsive to identification of a selected file address location for determining from said record means the encryption key signal  
105 associated therewith for setting the generator means to supply the associated encryption key signal, decryption means disposed to receive encryption key signals from the generator means and encrypted file data from the storage means  
110 and operable in accordance with said logical encoding combination to decrypt the file data at said selected file address location, and means operable upon the decrypted file data for altering the generator means to supply a new encryption  
115 key signal for re-storing the file data at the selected file address location newly encrypted with a new encryption key signal, said means altering the record means to produce an indication of the new encryption key signal  
120 associated with file data in the selected file address location.

In apparatus as set forth in the last preceding paragraph, it is preferred that said circuit means is responsive to the indication in said record means that a selected file address location was not previously accessed for setting said generator means to supply the initial encryption key signal to the decryption means.

update the access authorization information in storage in the memory means 15 in response to authorizations granted, and to generate historic files in encrypted form of the encryption keys used to decrypt and re-encrypt each file accessed from the memory means 17. In addition, the module 9 operates in a controlled reinitialization mode to restore all files in the memory means 17 to a new, standard encryption key after numerous accesses of files in the memory means 17 have been authorized. The number of accesses before requiring reinitialization is determined by the memory capacity in the module 9.

Referring now to Figures 2 and 3 in addition to Figure 1, there are shown a flow chart and a block diagram, respectively, illustrating the operation of the system of Figure 1 under control of a central processing unit 11. In operation, a person or entity, R, requesting access to a particular file may enter personal identification numbers, information about the particular file, and the like, via the keyboard controller 13. Optionally, a personal-identity verification routine may be performed in conventional manner (as disclosed, for example, in U.S. Patent 3,938,091 or 4,198,619) and the access-authorization files in the memory means 15 may be searched for authorization to access the requested file. All such files in memory means 17 are initially encrypted with an initial key code,  $K_0$ , in a conventional manner (for example, using the Data Encryption Standard module available from the National Bureau of Standards) by encrypting the file data in an encryption module 21 with key code,  $K_0$ , from a key code generator 23.

With authorization established 25, the particular file #X may be accessed, but decrypting the file #X requires the correct key code. For this purpose, a key-usage control file 19, later described herein in detail, is searched to determine if the file #X was previously accessed. The conditions of prior access, namely, that it was, or it was not previously accessed, are possible. If it was not, then file #X will not appear in the key-usage control file, an indication that it appears in storage provided by the memory means 17 encrypted with the initial key code,  $K_0$ . The key code generator 23 is capable of generating a sequence of different key codes  $K_0, K_1, K_2, K_3, \dots, K_n$  and is set to supply key code  $K_0$  to a decryption module 27 (which, of course, may be the same type of DES module, or may be the same module, as the encryption module 21). The requested file #X may therefore be decrypted in conventional manner using the key code  $K_0$  to provide accessed data 29 in clear text. The data is then returned to storage, either without or with new data modifications 31 that reflect a data-oriented transaction such as sale, deposit, withdrawal, or the like, and is re-stored in encrypted form using a new key code  $K_1$ . This is accomplished by resetting 38 the key code generator 23 to supply the key code  $K_1$  to the encryption module 21 and returning the data 33 with or without modifications for encryption in the

module 21 with the key code  $K_1$ . In addition, the key-usage control file 19 is updated to reflect that the file #X was accessed and now resides in storage newly-encrypted with the new key code  $K_1$  in the sequence. Further, the access-authorization in the memory means files 15 may be updated optionally to inhibit further access to file #X by user R, for example, to inhibit R's further access until a "new date", or until accessed by another user, or the like. Subsequent access to file #X by user R, if continuously authorized, or by any other user must be via decryption with the key code  $K_1$ .

If file #X was previously accessed, then the key-usage control file 19 will contain the entry of file #X having been previously accessed and returned to storage encrypted with a new key code  $K_1, K_2, \dots, K_n$ , depending upon the number of previous accesses to file #X. Thus, with reference to the chart of Figure 4 which illustrates the typical entries in the key-usage control file 19, if file #X is file #00100, then the previous accesses to this file resulted in its being re-stored encrypted with key code  $K_2$  (at entry 37). The search of the key-usage control file 19 thus indicates that file #00100 was previously accessed twice and now requires decryption with key code  $K_2$ . If authorization of the requesting user is still valid 39, then the key code generator 23 is set to supply the key code  $K_2$  to the decryption module 27 in order to furnish the data in this file in clear text 29. Re-storing the data from this file in modified or unmodified form is accomplished by resetting 38 the key code generator 23 to supply the key code  $K_3$  (entry 41 in Figure 4) to the encryption module 21 for encryption therein of the returned data with the new key code  $K_3$ . All retrievals of data in storage in the memory means 17 may be by destructive read of information in the addressed file so that data for restoring therein may be written in the newly-encrypted form. After numerous accesses to files in storage in the memory means 17, the key-usage control file 19 will typically include entries as illustrated in Figure 4. Such a file optionally may also include codes to identify the particular users who gained access to each file. The file 19 thus provides an audit record of the accesses to the files in the memory means 17. In addition, the key-usage control file 19 is in encrypted form since it neither reveals the data in storage in the memory means 17 nor the actual key codes  $K_1, \dots, K_n$  (only generated by the generator 23) required to decrypt the data in storage. Further, the key codes  $K_0, \dots, K_n$  which serve as file-protect codes can be generated internally in conventional manner, for example, by a random-number generator 23 and therefore need not be known to anyone.

After numerous accesses to the data in storage 17 which approaches the limit of the sequence of key codes for any particular file, or on a periodic basis, the entire collection of files in storage 17 may be re-encrypted with a new initial key code  $K_0'$  of a sequence of new key codes  $K_0', K_1', \dots, K_n'$ .

10. Apparatus according to either one of claims 7, 8 and 9 and further comprising:  
 access record means for storing data  
 representative of the authorization of users  
 to selectively access file data in said storage  
 means; and  
 means disposed to receive identification data  
 from a user, and coupled to said circuit  
 means for inhibiting the generator means  
 from supplying an encryption key signal to  
 said decryption means for an unauthorized,  
 identified user.
11. Apparatus according to claim 10 comprising  
 means responsive to re-storing of file data at the  
 selected file address location newly encrypted with a  
 new encryption key signal for altering the identified  
 user's authorization in said access record means to  
 access said selected file address location.
12. Apparatus according to claim 8 comprising  
 initializing means coupled to said generator  
 means, said encryption means and decryption  
 means and to said record means for setting the  
 generator means to selectively decrypt file data in  
 each file address location using the encryption  
 key signals from said generator means  
 established from the record means for each such  
 file address location, and for re-encrypting the  
 decrypted file data for each file address location  
 using a new initial encryption key signal for  
 restorage at the respective file address location.
13. Apparatus according to claim 12 wherein  
 said initializing means responds to indication from  
 said record means of no previous access to a  
 selected file address location for decrypting file  
 data therein in using an initial encryption key  
 signal and for re-encrypting the decrypted file  
 data using a new initial encryption key signal to  
 re-store the newly encrypted file data at the  
 respective file address location.
14. Apparatus for securing data files in storage  
 against unauthorized access substantially as  
 hereinbefore described with reference to the  
 accompanying drawings.
15. A file access record produced by a process  
 comprising the steps of:  
 storing at selected file address locations file  
 data that is encrypted as the logical  
 combination of file data and selected ones of  
 a plurality of encryption key signals;  
 decrypting file data at a selected file address  
 location using the encryption key signal  
 associated therewith in accordance with said  
 logical combination;  
 re-encrypting the decrypted file data as a  
 logical combination thereof and a new  
 encryption key signal for restoring at the  
 corresponding file address location; and  
 producing said file access record as the  
 compilation at least of the number of times  
 each selected file address location was  
 decrypted and information indicative of the  
 encryption key signals with which the file  
 data at each selected file address location  
 was re-encrypted and re-stored therein.